

Low Power Indoor (LPI) Wi-Fi Will Not Cause Harmful Interference or Impact Availability of 6 GHz Fixed Service (FS) Incumbents

Summary

- The 6 GHz band is crucial to enabling the future of broadband connectivity, which the cable industry is building via 10G
- CableLabs recently presented* a real-world simulation of LPI Wi-Fi in 6 GHz, using empirical network data and ranges of other relevant parameters, including worst-case values, which showed that FS users will not experience harmful interference
 - This analysis showed no change to ‘five-9s’ availability for FS even with unrealistically high noise rise
- We now apply this simulation method to the corner-case links presented recently by AT&T
- We find that real-world Wi-Fi operations will not harm even these corner cases

AT&T Analysis is Inaccurate

- AT&T recently presented* five FS links and speculated that Wi-Fi would cause harmful interference
- Their static analysis suffered from a host of unrealistic assumptions and errors, as noted by Broadcom, Cisco, Facebook, Google, Intel, Microsoft, and Qualcomm**
- Interference analysis should simulate ranges of relevant parameters, including worst-case and real-world values, which AT&T fails to do

* See November 12, 2019 *Ex Parte* notice by AT&T Services

** See December 23, 2019 *Ex Parte* notice by Broadcom, Cisco, Facebook, Google, Intel, Microsoft, and Qualcomm

Simulation of All Possible Outcomes Confirms No Harmful Interference

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- Incorporating ranges of parameters measures worst-case values and demonstrates real-world system interactions
- We have simulated these interactions over billions of possible parameter combinations, including the values used by AT&T and other values reflecting real-world conditions
 - This approach is consistent with our recent NYC market simulation, which incorporated empirical data on Wi-Fi airtime utilization, and ranges of values pertaining to building entry loss, bandwidth, power, and other factors
- We find that LPI Wi-Fi will not cause harmful interference to the links presented by AT&T, and will not materially change link availability

Detailed Results

<u>AT&T Case</u>	<u>Probability that I/N will exceed -6 dB*</u>	<u>Impact to 99.999% Availability (seconds per year)**</u>
1A	0.00007	0.008
1B	0.00008	0.010
2	0.00005	0.005
3	0.00010	0.015
4	0.00004	0.004
5	0.00014	0.028

Link availability maintained in all cases

* Reflects simulation runs where I/N exceeded -6 dB across billions of iterations. Does not refer to link availability or constitute harmful interference.

** Reflects link availability impact across all simulation runs, a de minimis (milliseconds per year) availability impact; 99.999% is equal to 315 seconds of unavailability per year.

- Even for these corner-case links, there is, at most, only a 0.00014 chance that LPI Wi-Fi will cause I/N to exceed a conservative -6 dB I/N threshold
- Nor would there be any material change in FS link availability; at most we observe 28 milliseconds per year, which is not measurable or impactful to FS links
- LPI Wi-Fi will therefore not cause harmful interference to these or other FS links, especially in light of technical features of WiFi6 that will further enhance coexistence

Power Spectral Density

- Our analysis has shown that 6 GHz LPI Wi-Fi will coexist well with FS in the real world
- Nevertheless, if the FCC wishes to provide further assurance of this, it could limit power spectral density to 8 dBm / MHz radiated power
- This limitation would cap transmit power at smaller Wi-Fi channel sizes, limiting the maximum possible noise into a FS receiver, while more fully enabling wider channels
 - This cap was not assumed in CableLabs' simulation
- This is a major reduction from the FCC's proposed PSD and may limit some use cases (e.g., dense user environments)
- Cable operators are prepared to support this PSD limit if required for rapid authorization of LPI Wi-Fi across the entire 6 GHz band
- PSD limitation of 8 dBm/MHz and indoor use provides more than adequate protection, while also enabling the advanced performance and capabilities of next-generation Wi-Fi

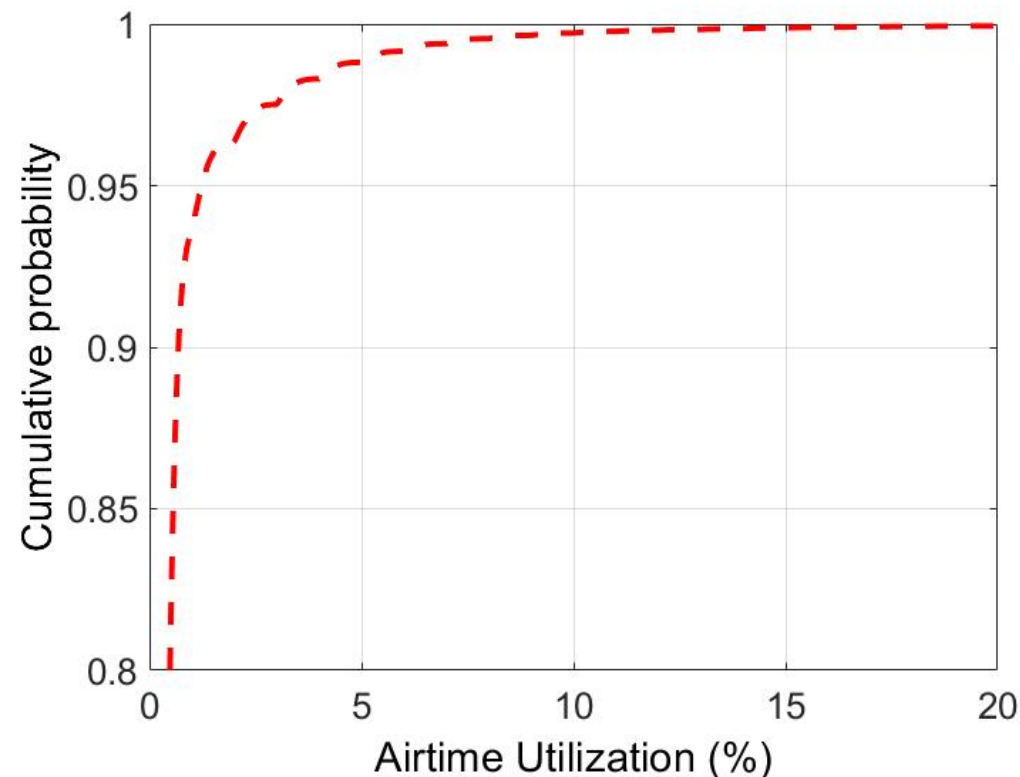
Conclusion

- Our simulation of AT&T's links, applying ranges of values including worst-case, confirms that LPI Wi-Fi will not cause harmful interference to FS and will not change FS link availability
- This finding confirms our earlier city-scale simulation of the NYC market, which also found no harmful interference to FS or change in availability
- The FCC should therefore authorize LPI Wi-Fi operations across the 6 GHz band to support broadband connectivity, and if needed, cap PSD at 8 dBm / MHz EIRP

Appendix: Parameters Used in Simulation of AT&T Links

Empirical Data on Airtime Utilization

- Airtime utilization contributes to the probability of interference from RLAN to FS
- Collected data from 500k 5 GHz APs across the U.S.
 - Entire data set integrated into simulation
 - Residential APs were polled; enterprise APs have lighter usage*
 - Airtime utilization includes all Wi-Fi activity, data and management traffic of APs
- Weighted average airtime utilization: 0.4%



* See ECC Report 302, "Sharing and compatibility studies related to Wireless Access Systems including Radio Local Area Networks (WAS/RLAN) in the frequency band 5925-6425 MHz", approved May 29, 2019 (p.18); as well as Joseph et al, "Determination of the duty cycle of WLAN for realistic radio frequency electromagnetic field exposure assessment", *Progress in Biophysics and Molecular Biology*, 2012.

RLAN Parameters

- Wi-Fi AP is placed in the location of concern noted by AT&T
- Bandwidth & Power:
 - Use distributions aligning with ECC Report 302
- Antenna pattern taken from commercial products

Channel Bandwidth Distribution				
Channel BW	20 MHz	40 MHz	80 MHz	160 MHz
RLAN %	10%	10%	50%	30%

Bandwidth and power values taken from ECC Report 302. Note that power distribution extracts the AP-side information from Table 6 of Report 302, and excludes lower-power client-side information.

Power Distribution						
Indoor Tx EIRP	1000mW	250mW	100mW	50mW	13mW	1mW
RLAN %	1%	12%	6%	19%	54%	8%

FS Parameters

- Specific FS link information is used, consistent with AT&T cases
- Transmitter and receiver location information and height is taken from ULS
- Bandwidth, frequency, polarization, antenna gain and other precise link parameters are consistent with ULS and other public sources

Other RF Parameters

- WINNERII Line of Sight path loss model used
 - Rural, suburban, and urban used as appropriate to the specific case being analyzed
- Building entry loss represented as a distribution between 10 dB and 30 dB
 - Captures a range of building material factors and indoor AP placement possibilities, conservatively reflecting traditional buildings (thermally efficient buildings will show higher loss)
 - Represents the bulk of possible losses in ITU-R P.2109 and in AT&T's analysis